

Oct. 13, 1964

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REPULPABLE ADHESIVE TAPE AND METHOD OF  
SPLICING PHOTOGRAPHIC PAPER  
Filed Sept. 14, 1961

3,152,940

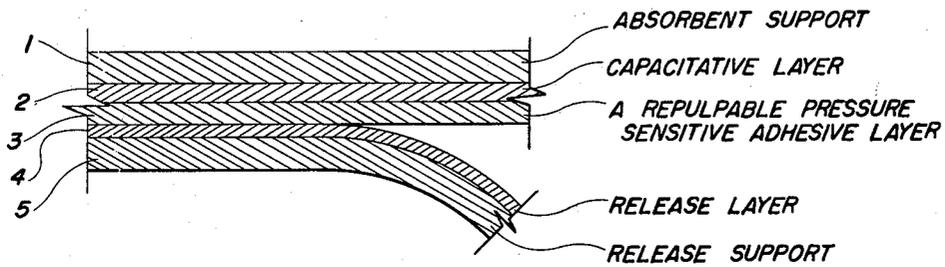


FIG. 1

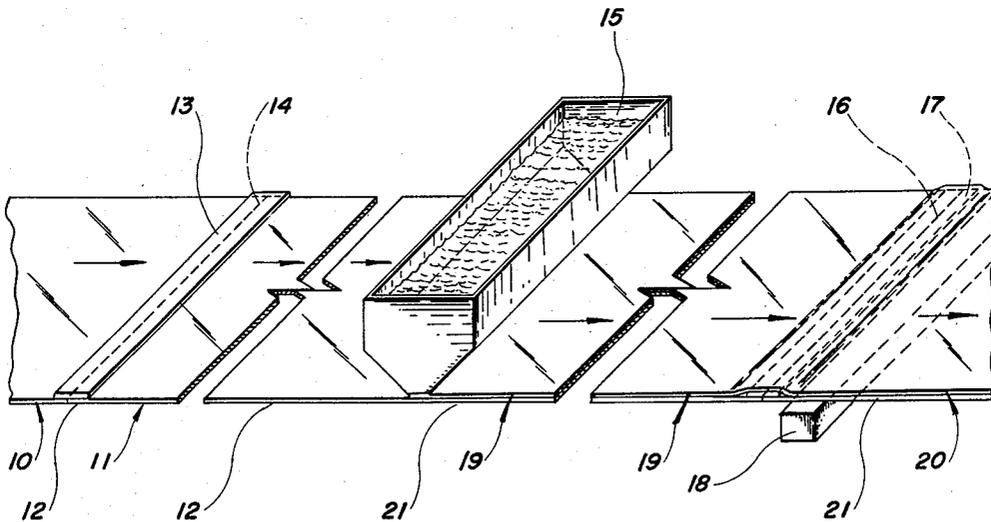


FIG. 2

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1

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## REPULPABLE ADHESIVE TAPE AND METHOD OF SPLICING PHOTOGRAPHIC PAPER

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Filed Sept. 14, 1961, Ser. No. 138,068  
3 Claims. (Cl. 156-157)

This invention concerns a pressure-sensitive adhesive tape, more particularly, a tape which can be used for splicing paper webs and recovered in paper repulping operations.

In the continuous handling of paper webs it is necessary to splice rolls together to preserve continuity. However, the requirements for splicing means have been exacting and it has been desirable to find a splicing tape having thereon a pressure-sensitive adhesive which would have a strong holding force when the tape is pressed against various objects. It should adhere to ordinary paper webs having a relatively coarse surface as well as to coatings which may be thereon. This is particularly important in the photographic industry where coatings are customarily applied to the paper web which are highly pigmented with barium sulfate in order to increase the whiteness of photographic prints.

In the manufacture of photographic paper, the splices on the paper web must be removed, since they would interfere with the finished product. The removed splices constitute a large amount of waste material which can be recovered advantageously providing the splicing tape can be processed satisfactorily in the same repulping baths used for other paper wastes. This requires an alkali-soluble adhesive as well as a paper backing for the adhesive tape.

The detection of the splices in photographic paper has presented a problem, particularly when the photographic paper has thereon a light-sensitive photographic emulsion. Various methods have been proposed for such detection, such as identifying these splices by means of punched holes, ink marks and tapes. The punched holes are detected photoelectrically and electromechanically for removal during finishing operations, but mechanical hole punching limits marking to web speeds below 50 feet per minute so that this method has been undesirable.

Ink marks may identify imperfect coatings and are detected photoelectrically and visually for subsequent removal, as are tapes which may be detected mechanically as well. However, photoelectric systems are limited to the infrared region when used with photographic emulsions, and this reduces their efficiency. Also, visual inspection is impossible due to lighting limitations. In addition, photoelectric detection is limited to reflective methods for photographic paper because of the opacity of the paper and its baryta coatings. Therefore, reflective photoelectric detection at high speeds is subject to many limitations and cannot be relied upon for detection of all areas to be removed.

In addition to the requirements of repulpability and detectability under pool light conditions, a satisfactory adhesive tape should have good keeping qualities and retain its cohesive and tacky state when exposed either to dry or humid atmospheric conditions. It should not be adversely affected when adhered to such diverse surfaces as photographic-emulsion coated paper or paper carrying water resistant coatings which may be somewhat hydrophobic in nature.

An adhesive tape for use with photographic paper has an added requirement which can be serious in its compatibility with photographic emulsions. All of the com-

2

ponents used in the tape must be photographically inert so that the use of this tape, including its direct contact against photographic emulsions, fails to affect them in any way.

We have discovered and adhesive tape which can be detected using an electrical capacitative system and which is repulpable with paper waste and compatible with photographic emulsions.

One object of this invention is to provide a repulpable pressure-sensitive adhesive tape. An additional object is to provide a repulpable adhesive tape which can be detected using an electrical capacitative system without requiring the use of photoelectric means. Another object is to provide a repulpable pressure-sensitive adhesive tape which is compatible with photographic emulsions and which has good adhesion properties when used on various substrates. A further object is to provide a method of detecting splices in photographic paper which must be processed in limited visual light.

The invention is described more fully hereinafter with reference to the drawing of which FIG. 1 is a schematic sectional diagram of an embodiment of the novel tape and FIGURE 2 is a schematic illustration of the method of the invention.

In FIG. 1, the absorbent support 1 is an internally creped paper base having thereon a capacitative layer 2 and a repulpable pressure-sensitive adhesive 3 which is in contact with a release layer 4 carried on a release support 5.

In FIG. 2, parts 10 and 11 of the moving paper web 12 are spliced with the novel tape 13 at splice 14. The moving web 12 is coated with a photographic emulsion, e.g., from emulsion hopper 15. The splice 16 between parts 19 and 20 of coated web 21 is then detected without exposing the emulsion to light when tape 17 passes over the electrical-capacitative splice detector 18.

The above objects are obtained by coating on an absorbent paper base a paper-repulpable compatible conductive layer. Over this layer is coated a repulpable pressure-sensitive adhesive layer which is alkali soluble. This pressure-sensitive surface may be protected by having contacted against it a release support having coated thereon a release layer which is easily removed from the pressure-sensitive adhesive layer without adversely affecting its adhesion characteristics.

The paper support is preferably an internally-creped bleached kraft paper base having a basis weight of about 50 pounds per 300 square feet. It will be clear that other types of paper may be used, such as porous tissue paper, and that, for some purposes where repulping is not important, a cloth or similar backing may be used. The strength of the paper backing may be improved by imbedding fibers or the like which may be removable in the repulping operation.

The capacitative layer is preferably a water-soluble conductor such as an aryl quarternary ammonium type polymer made by bubbling trimethyl amine through a polymer made by epichlorhydrinating a chlorinated bisphenol A.

In the event that repulping is not required or desirable, a metallic surface may be used, such as aluminum foil or the like, and the paper base dispensed with, since the metallic foil would act as both the capacitative layer and the adhesive tape support.

The repulpable adhesive is based on an acrylic acid ester copolymerized with acrylic acid. The esters which are operative in our invention include the esters of aliphatic alcohols having 1-8 carbon atoms. The proportion of acrylic acid to ester ranges from 10 to 40% by weight, but the inherent viscosities of the copolymers that are useful range from 0.90-1.40, measured in ace-

3

tone. The preparation of the copolymer is not critical, but may be carried out using the known methods of polymerization. A typical method of polymerization is illustrated in Example 1 which also illustrates a preferred copolymer containing about 30% by weight acrylic acid.

Additives to the copolymer which may be used in order to prepare the adhesive may be varied widely in order to adjust the adhesive characteristics, coating viscosity and the like. The composition in our preferred embodiment contains 20 to 35% by weight of an acrylic acid-acrylic ester copolymer, 5 to 20% by weight of a water-soluble wax, and 45 to 75% by weight of a solvent (from which it is calculated that this composition exclusive of solvent contains from 50-88% by weight of the copolymer and from 12-50% by weight of the wax). The solvent can be selected from solvents, having a common solvent action on the copolymer and the wax, including acetone and lower alcohols, disclosed on page 49 of the publication Carbowax Polyethylene Glycols, 1960, published by the Union Carbide Corporation, 270 Park Avenue, New York 17, New York. Cornstarch, particulate silica, acid phthalates, and acid phosphates may also be added to the mixture.

A satisfactory water-soluble wax may be a hydroxy polyalkylene material such as polyethylene glycol and polypropylene glycol of about 1,000 and about 400 molecular weight respectively. Other suitable hydroxy-polyalkylene materials may be used, provided they are water soluble and fully compatible with the acrylic acid-acrylic ester polymer. These waxes are non-volatile and non-hygroscopic.

The silica which may be used should have a particle size within the range of about 0.01 to 0.03 micron and should be incorporated in the adhesive mass in amounts of about 1 to 10% by weight silica. The best results are obtained where the silica is included in amounts of about 2 to 8% by weight. A fine particulate silica found to be particularly suitable is that sold by Godfrey L. Cabot, Inc., under the trade name "Cab-O-Sil." This silica is prepared by the vapor-phase hydrolysis of silica compound.

Although our preferred embodiment comprises a pressure-sensitive adhesive tape having an adhesive coating on one surface, we can also employ the same adhesive on both surfaces of the paper base support and employ a removable release support having a release agent coated on both sides of the release support.

Various release agents known in the art can be used satisfactorily on the release support or on the back of the single-coated adhesive tape. In our preferred embodiment, we use a silicone release agent but a combination of cellulose acetate butyrate and castor wax, as disclosed in U.S. Patent 2,562,351, may be used satisfactorily. In addition, chromium stearate chloride, either alone or mixed with ethyl cellulose, may be used.

Instead of employing a release support and release agent thereon, it may be possible to use a hydrophobic polymeric material which, in itself, acts as a release agent. For instance, a thin layer of polyethylene, polyethylene terephthalate, or the like, may be employed which will strip readily from the adhesive surface.

Various methods of preparing the adhesive tapes described herein may be employed using well-known coating methods in the event that a double-coated tape is desired. The adhesive layer may be coated on one side of the paper tape and the adhesive which is intended for the other side of the paper tape coated on the release support, after which the tacky adhesive is contacted against the back of the paper tape and transferred thereby. This may facilitate handling the sticky material which can be somewhat of a problem in production.

The drawing discloses a vertical section of our preferred embodiment. An absorbent surface 1 internally impregnated creped paper is coated with a capacitive layer 2 over which is then coated a repulpably pressure-

4

sensitive adhesive layer 3. A release support 5 having thereon a release layer 4 is contacted against the pressure-sensitive adhesive layer 3.

The following examples are intended to illustrate our invention but not to limit it in any way:

#### EXAMPLE 1

The following is an example of the preparation of our polymers:

Into a one liter flask fitted with a reflux condenser was placed 75 g. of distilled ethyl acrylate, 36 g. of distilled acrylic acid, 480 ml. of acetone, and 0.555 g. of benzoyl peroxide. The solution was refluxed for 17½ hours in a 65° C. constant temperature bath. After cooling, the medium viscosity dope was poured slowly into distilled water to obtain a soft white polymer. This was washed repeatedly in fresh changes of distilled water by kneading and then dried in a 45° C. air oven overnight. The polymer, which had fused together, was cut into small pieces and redried in a 55° C. oven under a constantly applied water pump vacuum for 16 hours. The yield was 109 g. The inherent viscosity, as measured in a Cannon-Fenske type viscometer at a concentration of 0.25 g./100 ml. of acetone, was 0.96. Titration of a 1.000 g. sample in 200 ml. of 1:1 pyridine-water with N/2 NaOH to a phenolphthalein end point indicated an acrylic acid content of 29.9 weight percent. A smooth dope was made by adding 75 g. of the polymer to 150 ml. of acetone and tumbling overnight to dissolve.

Other copolymers were prepared following the same procedure except for the changes in the amounts used which are shown in Table I, along with other data pertaining to the product.

Table I

|                | Acrylic Ester | Grams | Acrylic Acid | Wt. Percent of Acrylic acid |                    | Inherent Viscosity <sup>b</sup> |
|----------------|---------------|-------|--------------|-----------------------------|--------------------|---------------------------------|
|                |               |       |              | Theory                      | Found <sup>a</sup> |                                 |
| Example 2..... | Methyl...     | 95.5  | 20           | 17.3                        | 16.3               | 1.20                            |
| Example 3..... | Ethyl...      | 100   | 18           | 15.3                        | 14.9               | 1.35                            |
| Example 4..... | Ethyl...      | 75    | 36           | 32.5                        | 29.9               | 0.95                            |
| Example 5..... | Butyl...      | 102.4 | 14.4         | 12.3                        | 11.7               | 1.10                            |
| Example 6..... | Butyl...      | 76.8  | 28.8         | 27.3                        | 23.8               | 1.19                            |

<sup>a</sup> Analyzed by titrating a 1.000 g. sample dissolved in 200 ml. of 1:1 pyridine-water with N/2 NaOH to a phenolphthalein end point.

<sup>b</sup> Determined by dissolving a 0.25 g. sample to 100 ml. with acetone and the flow time measured in a Cannon-Fenske type viscometer. Calculations were made in the usual manner.

#### EXAMPLE 7

In preparing the copolymers for use as a pressure-sensitive adhesive, it may be plasticized with a water soluble plasticizer and reinforced with a water dispersible solid. Alkali dispersible plasticizer and reinforcing "pigments" may also be used.

In detecting the splices, particularly where the use of light detection methods must be avoided or seriously limited, a non-contacting "change-in-capacitance" is used. This is detected on a capacitor-type transducer in a radio frequency circuit. This transducer is an open type capacitor in a radio frequency circuit which detects a change in capacitance caused by the marking material in the electrostatic field of the transducer. There is no need for physical contact and spacing is not extremely critical. Moreover, high speeds can be used satisfactorily since the change in capacitance can be indicated quickly.

We claim:

1. An adhesive tape comprising a paper support, a water-soluble electrically conducting layer thereon, and having on one side of the support a water-soluble adhesive comprising a homogeneous blend of about 50-88% by weight of an alkali-soluble acrylic acid-lower alkyl acrylic acid ester copolymer containing about 10-40% combined acrylic acid, the lower alkyl of said ester having 1 to 4 carbon atoms and said copolymer having an inherent viscosity of 0.90 to 1.40 as measured in a Cannon-

Fenske type viscometer in acetone at a concentration of 0.25 g./100 ml. acetone; about 12-50% by weight of a water-soluble wax of the class consisting of polyethylene glycol and polypropylene glycol; and an alkali-dispersible plasticizer.

2. A process for splicing and coating a web of photographic paper and determining the position of a splice in the web, which comprises splicing the roll of paper with a repulpable pressure sensitive adhesive tape having a paper support, a water-soluble electrically conducting layer thereon, and on one side of the support a water-soluble adhesive comprising a homogenous blend of about 50-88% by weight of an alkali-soluble acrylic acid-lower alkyl acrylic acid ester copolymer containing about 10-40% combined acrylic acid; about 12-50% weight of a water-soluble wax of the class consisting of polyethylene glycol and polypropylene glycol; and an alkali-dispersible plasticizer, coating a photographic emulsion on the web of paper and capacitatively sensing the position of the splice in the web of paper.

3. A repulpable pressure-sensitive tape comprising a paper support, an electrically conducting layer thereon, and having on one side of the support a water-soluble adhesive comprising a homogeneous blend of about 50-88% by weight of an alkali-soluble acrylic acid-ethylacrylate copolymer containing about 30% by weight of combined acrylic acid and having an inherent viscosity of 0.96 measured in a Cannon-Fenske type viscometer in acetone at a concentration of 0.25 g./100 ml. acetone; about 12-50% by weight of a water-soluble wax of the class consisting of polyethylene glycol and polypropylene glycol; and an alkali-dispersible plasticizer.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,152,940

October 13, 1964

Edward P. Abel et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 54, for "reflective" read -- reflective --;  
line 60, for "repupability" read -- repulpability --; column 2,  
lines 5 and 12, for "and", each occurrence, read -- an --;  
column 5, line 8, for "roll" read -- web --; line 15, before  
"weight" insert -- by --.

Signed and sealed this 6th day of April 1965.

(SEAL)

Attest:

ERNEST W. SWIDER  
Attesting Officer

EDWARD J. BRENNER  
Commissioner of Patents